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Department of
Agriculture

Forest Service

Technology &
Development
Program

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Management
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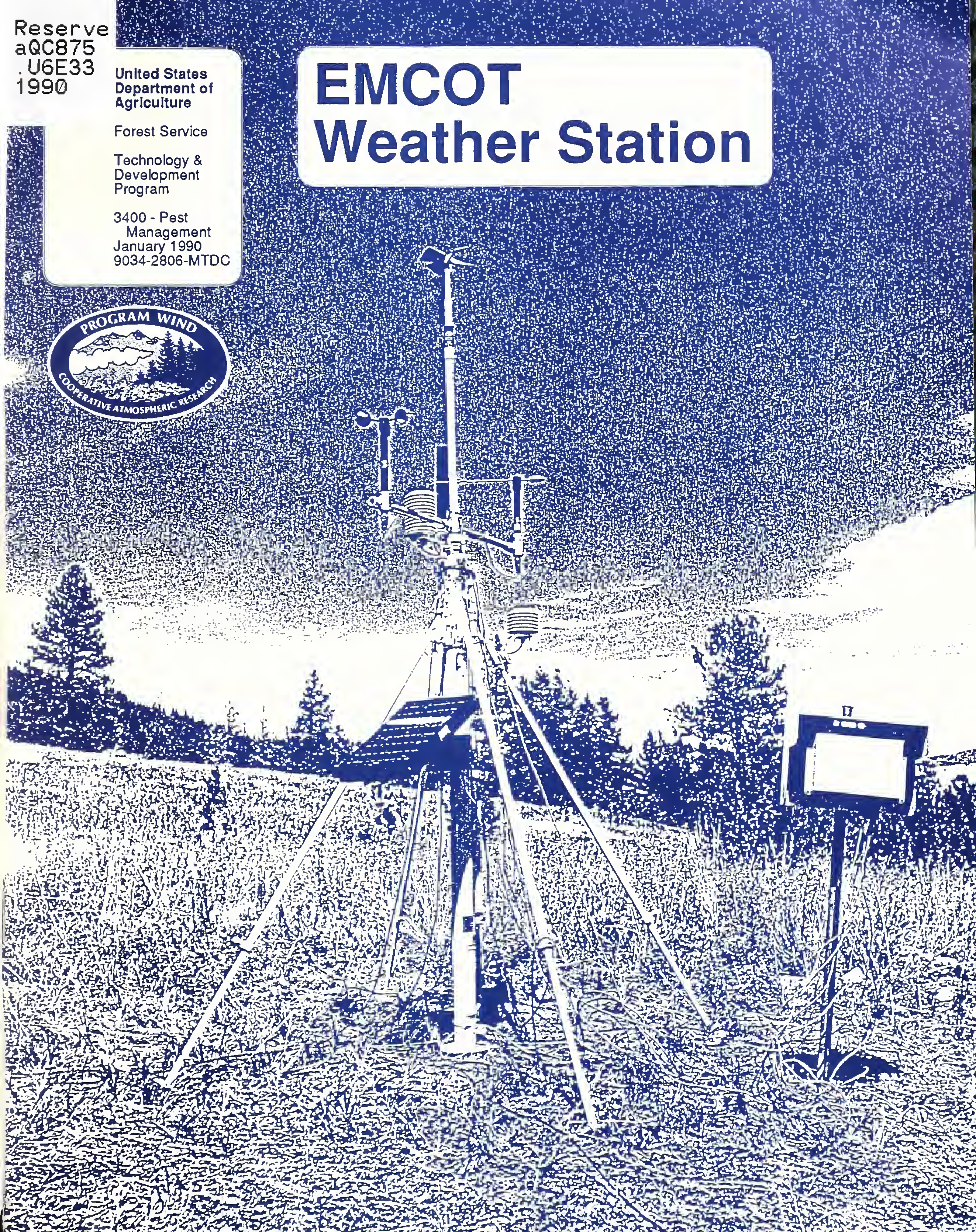
EMCOT Weather Station

PROGRAM WIND
COOPERATIVE ATMOSPHERIC RESEARCH



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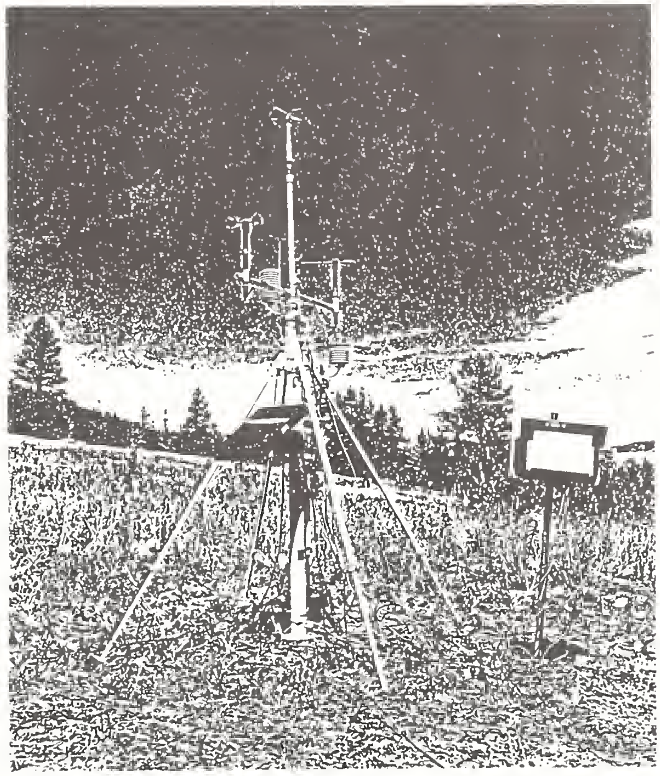
EMCOT Weather Station



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Objective

This report is a description of a prototype solar powered, portable weather station designed for final development and verification of the EMCOT model. This report is to provide interim documentation of the EMCOT model development and to provide information for others who may wish to use the prototype weather station in its present form.

To refine and verify the EMCOT principles that were demonstrated during Program WIND, a prototype weather station system was assembled. Criteria for the system were:

- Capable of being erected by one person
- Transportable in a sedan or pickup
- Real time screen display from 2 to 4 towers
- High frequency data, greater than 2/second
- Easily modified software
- Easily expanded to add new sensors
- Able to store 8 hours of data
- Sensors at least 20 feet high
- Able to display events graphically on the computer screen or printer
- Two temperature sensors, 4 and 20 feet
- Relative humidity sensor
- Fast response vertical windspeed
- Horizontal windspeed and direction

As part of the continuing cooperative Program WIND effort, one of the cooperators, the Department of Commerce, NOAA, Environmental Research Labs designed and assembled two prototype stations for us.

Background

The USDA Forest Service is engaged in the final phases of a cooperative meteorological program with the U.S. Army, Atmospheric Sciences Lab, and other agencies. The program is entitled Winds in Nonuniform Domains (WIND). Participation in Program WIND has provided a unique opportunity to verify and extend aspects of models that predict behavior of aerially released pesticides.

One of the models is the Event Model for Complex Terrain (EMCOT) EMCOT is a systematic organized approach to predicting the evolution of events within the atmospheric boundary layer that determines beginning and ending of weather suitable for aerial application of pesticides (Figure 1). These events are governed by a combination of physical processes. They are characterized by changes in three wind fields:

1. Gradient Winds
2. Valley Winds
3. Slope Winds (Figure 2).

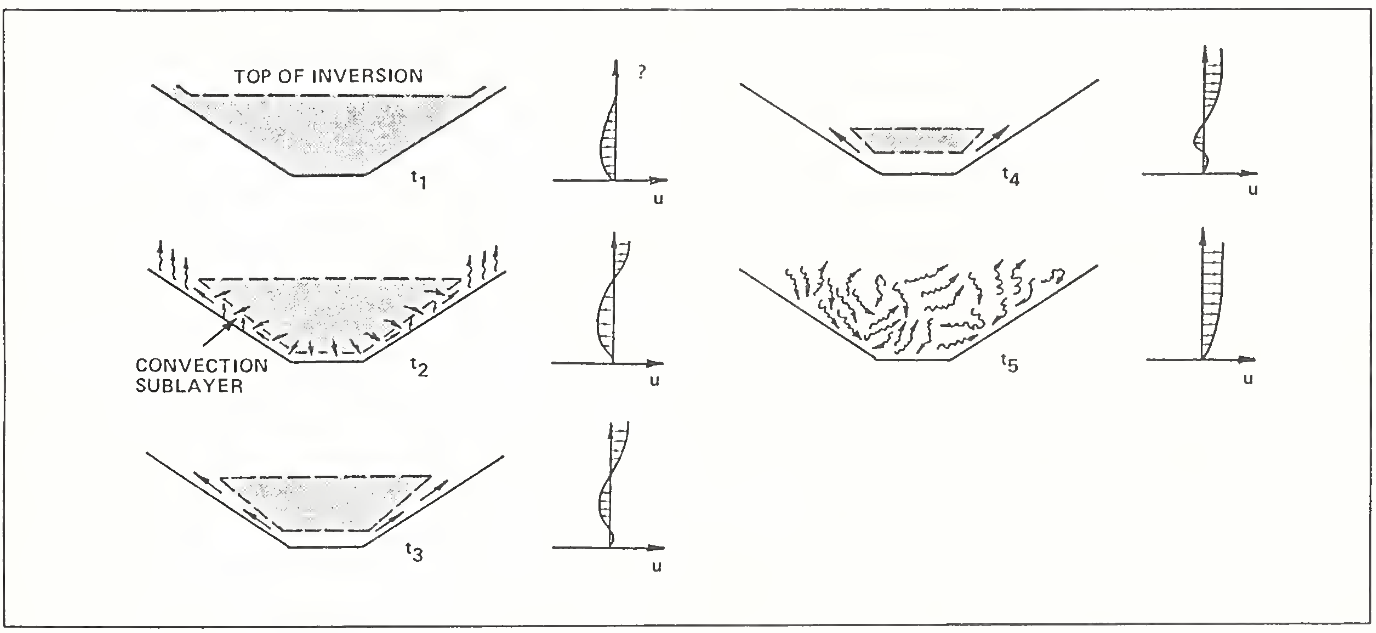

Figure 1.–Inversion breakup hypothesis. Stable core air is entrained into the convection sublayer and removed from the valley in upslope flows, producing a compensating subsidence over the valley center.

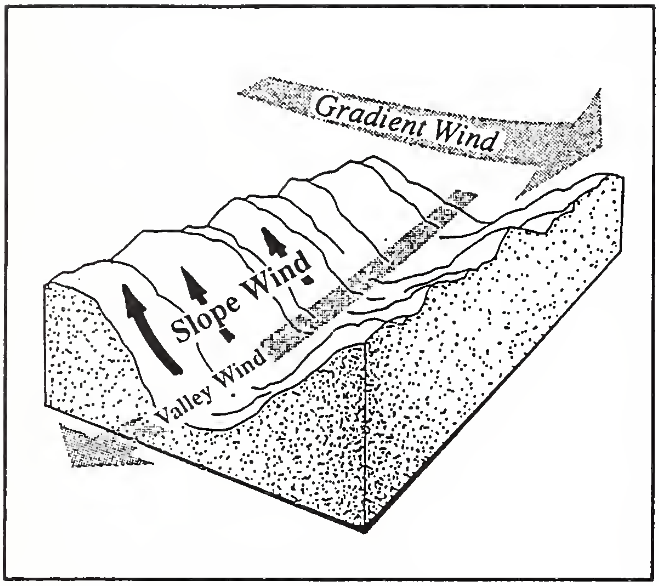

Figure 2.–Wind fields in complex terrain.

These wind fields change over greatly varying time and distance increments. Interpretation of changes in each of these wind fields will enable spray personnel to predict the stage of evolution of the changing boundary layer.

A key element in the observation is real time monitoring of events at several locations within a valley. Further, the data needs to be available in high frequency (greater than 0.5 observations per second) digital form that can be transmitted and manipulated mathematically by a computer. Figure 3 depicts deployment of a three-station meteorological data acquisition system that both stores and relays information to a central portable computer via a radio link. The system is a scaled-down version of the larger networks that were deployed successfully during Program WIND.

Only preliminary evaluation of the unit has been done. This report describes the equipment that makes up the EMCOT Station, along with a suggested deployment procedure, a chronology of events during each of the monitored spray applications, and an evaluation of the station.

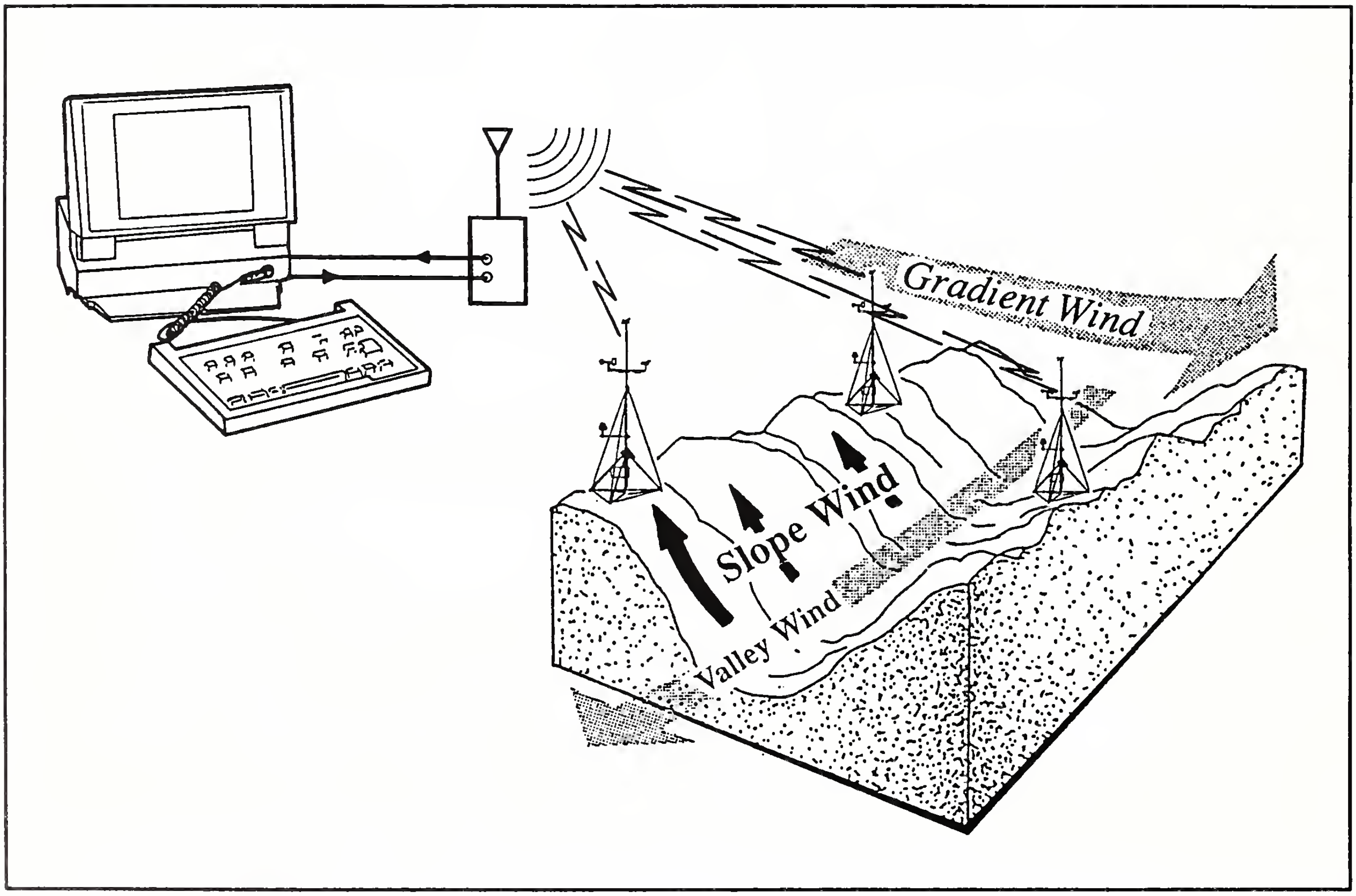

Figure 3.–Schematic of EMCOT data transmission.

The EMCOT Station successfully gathered meteorological data on the Heather Spray Project at Oakridge, Oregon, June 6 and July 6, 1989. The test area was a densely packed stand of high altitude Douglas-Fir seed cone trees, approx imately 60 to 80 feet tall. The general terrain did not exceed a 10-percent slope.

Equipment

The EMCOT Station is designed to accept any sensor that can emit an analog or pulse electrical output signal. The sensors employed during the Heather Spray Project measured:

1. Windspeed

2. Wind Direction

3. Temperature

4. Relative Humidity

Overview

The EMCOT Station hardware is composed of various meteorological sensors attached to a pneumatically actuated telescoping mast. Information obtained by the meteorological sensors is stored in a datalogger, which is physically attached to the sensors by electrical wires and located on the test site next to the mast in a Radio Frequency (RF) Substation housing (Figure 4). Operating power for the datalogger is obtained from a combination of a lead-acid battery located in the RF Substation housing and a solar panel mounted on the base of the telescoping mast. The datalogger stores any desired data in its memory chip (i.e., 2-minute averages of percent relative humidity). There is a keyboard with a 'LED' readout located in the RF Substation housing (Figure 5) that allows on-site programming of the datalogger as well as monitoring of the real-time measurements and stored data.

Figure 4.–EMCOT station hardware.

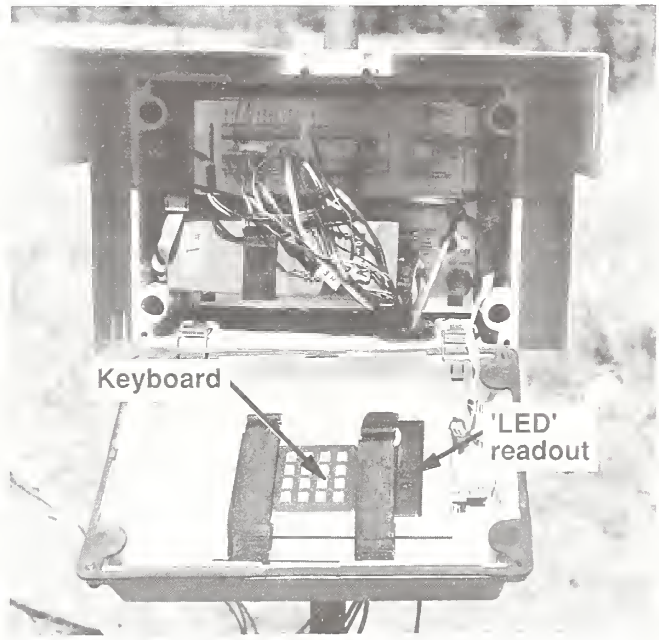

Figure 5.–The datalogger can be programmed on-site.

The RF Substation housing also contains a two-way portable radio (HT90 Motorolla), 4 Watt UHF, (Figure 6). This radio transmits the data stored in the datalogger via radio waves to a remote RF Base Station. The small antennas (Motorolla ST899, magnetic base) allow transmissions of 2 to 3 miles, depending on obstructions. Large Yagi antennas allow transmissions of 60+ miles, depending on obstructions. Radio repeaters can also be utilized when necessary but they must use Simplex packet data transmission. The two-way portables have only line-of-sight capability. Collection of the datalogger information is done remotely by an RF Base Station that contains a two-way portable radio linked to an RF Modem (Figure 7). The RF Modem is hard-wired to a computer via a PC Board and coaxial cable to a serial port on the computer. After the RF Base Station receives the incoming data, it transfers it to the computer as a comma delineated ASCII numeric file. A 12-volt DC current is required to operate the RF Base Station so an internal transformer allowing the system to operate from a 120-volt AC current is provided.

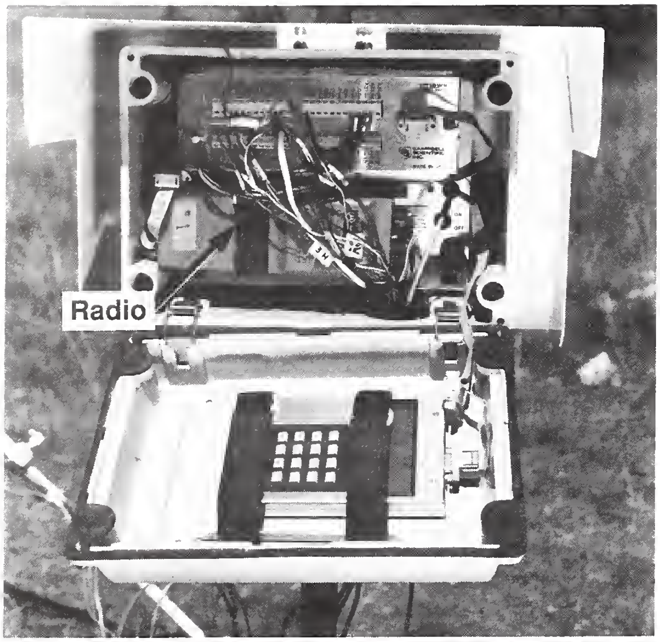

Figure 6.–Two-way portable radio.

software, monitor-viewed or permanent paper charts can be generated. The printer used to generate the permanent charts requires a 120-volt AC current. Currently, there is no provision for generating the permanent charts away from an electrical outlet.

Major Components

Datalogger(1) (Figure 8) — The datalogger (Campbell Scientific, Inc. (CSI) Model CR10) can be purchased with 16 k or 64k of internal random access memory (RAM). The Datalogger used on the Heather Spray project had its' memory expanded to 64k. There are five areas of RAM, which consist of system memory, program memory, input storage, intermediate storage, and final storage. The default size of final storage in the CR10 is 29908 two byte locations in the 64k version (i.e., If 2-minute averages are stored for 21 data points, the datalogger can store approximately 47 hours of data). When taking single-ended measurements, there are 12 analog inputs available (i.e., temperature measurement uses one single-ended analog channel). If differential measurements are to be taken, the 12 analog channels may be used as six paired differential channels.

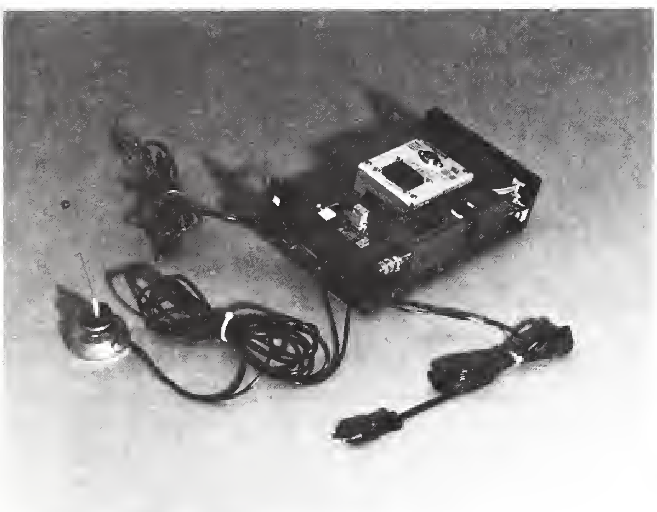

Figure 7.–RF Base station with cover removed.

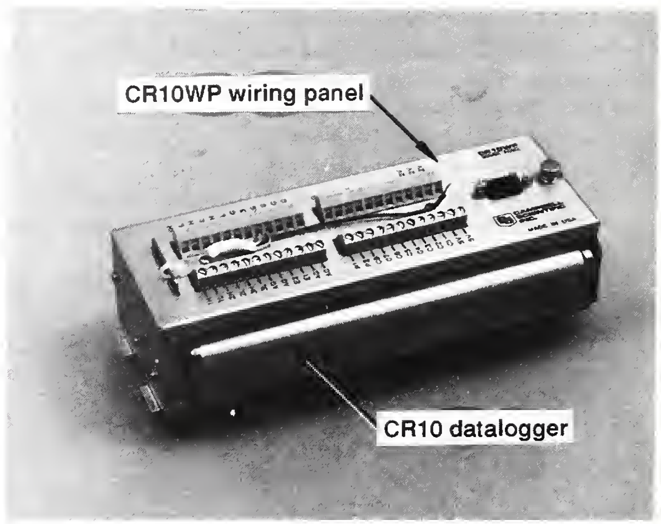

Figure 8.–CR10 datalogger and CR10WP wiring panel.

The RF base station used on the Heather Spray Project was modified to allow the use of a vehicle cigarette lighter receptacle as a power source. Power for the computer comes from the internal batteries of the computer. These batteries can run about 3 hours in the field and require about 2 hours to fully recharge. A power supply requiring a 120-volt AC input current is provided by the Zenith Company to recharge the batteries. Once the data is processed with the

The channels on the wiring panel (CR10WP) of the CR10 are labeled alpha-numeric (Figure 9). Channel 1 is 1H, 2 is 1L, 3 is 2H, 4 is 2L. The 12 analog input channels are labeled 1H through 6L. In a differential measurement the voltage on the H input is measured with respect to the voltage on the L input. Two pulse counter input channels are also available (i.e., windspeed from the three-cup anemometer uses a pulse channel). The throughput rate is

the rate at which a measurement can be made and the resulting value stored in Final Storage. The maximum throughput rate for fast single-ended measurements with standard software is 192 measurements per second (12 measurements repeated 16 times per second).

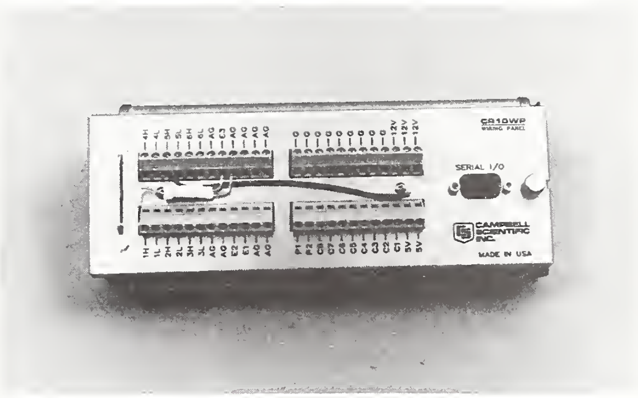

Figure 9.–CR10WP wiring panel.

RF Modem(2) (Figure 10).—The function of the RF Modem (CSI Model DC95) is to establish an RF link between a computer or terminal and a CSI datalogger. The DC95 connects to a radio transceiver that transmits and receives the modulated RF carrier. This modulated carrier transmits the information required to transfer data and commands. The microprocessor-controlled DC95 automatically codes all transmissions for specific communication paths. This allows up to 255 stations to be accessible using a single frequency. Any station on the same frequency can also be used as a repeater in a specified communication path to extend the range of a network.

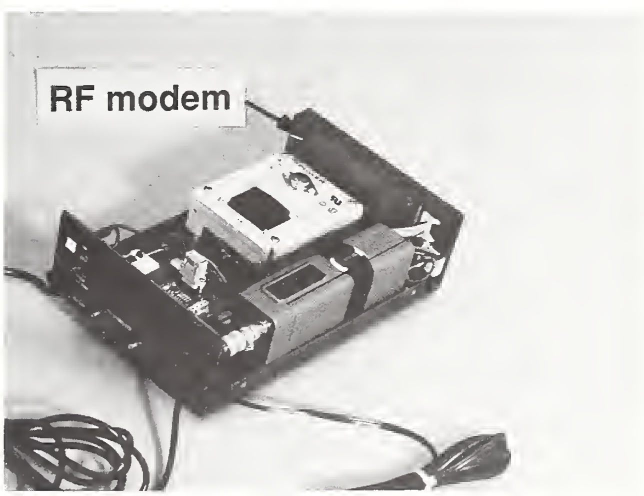

Figure 10.–Location of RF modem in base station.

RF Base Station (3) (Figure 11).— The PS232 RF base station provides a "single box" desktop base station system incorporating the following features: DC95 RF Modem, UHF radio, appropriate antenna and cable, +12 volt power supply and PC Board.

Figure 11.–RF base station with computer and printer.

RF Substation (4) (Figure 12).—An RF Substation with a datalogger consists of a +12 volt power supply (lead-acid battery) with 12-volt charging regulator (CSI Model 021/LA), external charging circuitry (solar panel), DC95 RF Modem, transceiver, appropriate antenna and cable, and CSI datalogger (10CR).

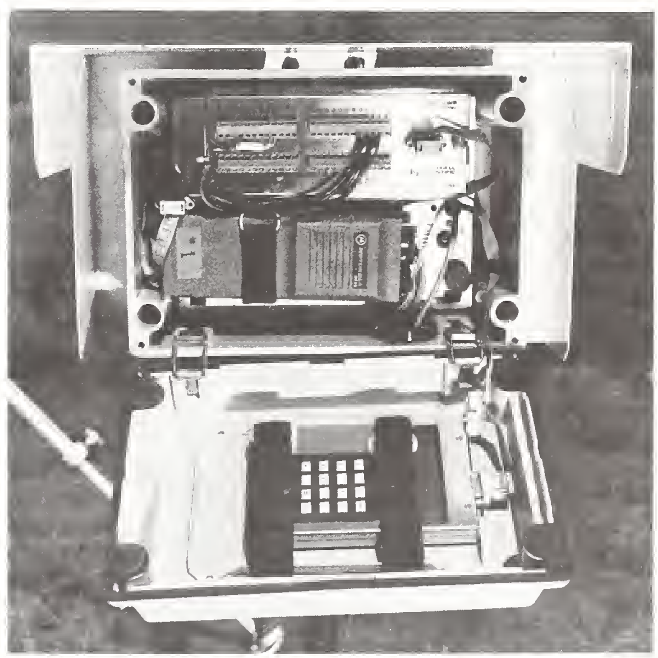

Figure 12.–RF substation with cover off.

Computer (Figure 13).—The computer used on the Heather Spray Project was a Zenith 386 Turbo-Sport. The level of performance offered by the Turbo-Sport is not required to make the EMCOT Station work. Any computer able to work with ASCII files and having the ability to download data to a computer disc will suffice.

Figure 13.–Computer.

Printer (Figure 14).—The printer used on the Heather Spray Project was a Okidata, Microline 390, 24-pin printer. It should be noted that any 24-pin printer will work.

Figure 14.–Printer.

Mast(5) (Figure 15).—The pneumatically operated telescoping mast (Type DAF 20 manufactured by Clark Mast) has an extended height of 6.24 meters (20.5 ft) (Figure 16) and a retracted height of 1.83 meters (6 ft) (Figure 17). It is made up of five sections. Approximate weight is 30 kg (66 lbs). Maximum unguyed safe windspeed is 32 km/hr (20 mph). Maximum guyed safe windspeed is 120 km/hr (75 mph). This company also makes masts that are extendable to roughly 25, 30, and 40 feet.

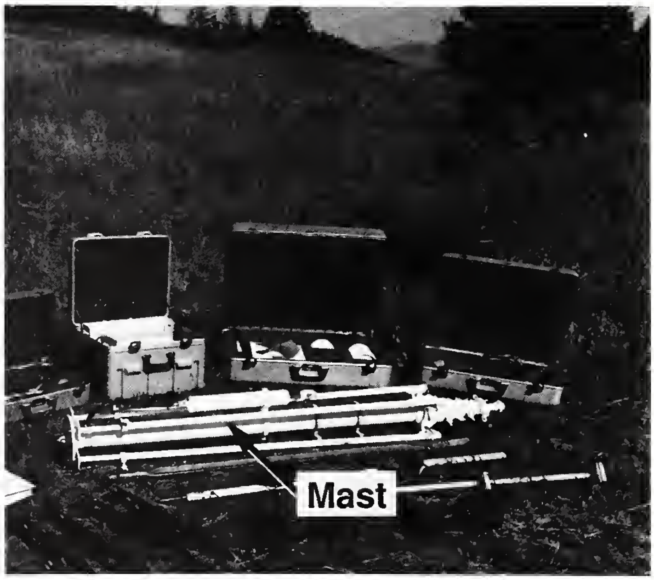

Figure 15.–Pneumatically operated telescoping mast.

Figure 16.–Mast can be extended to 20.5 feet.

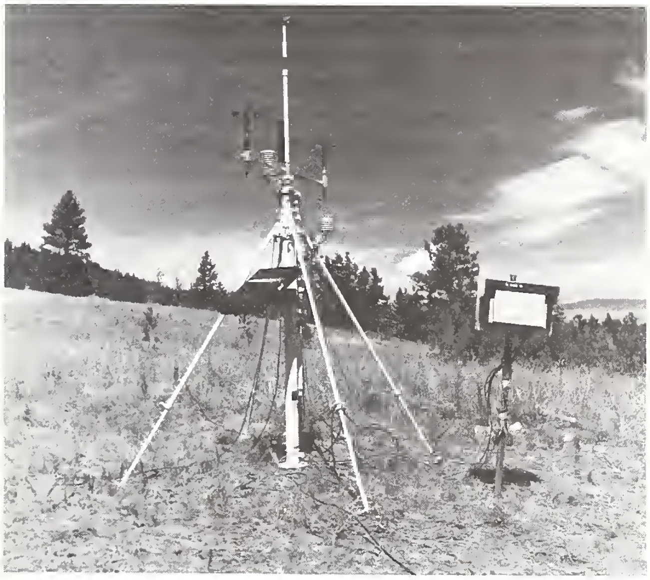

Figure 17.–Retracted mast height is 6 feet.

Solar Panel (6) (Figure 18).—The Solar Panel (CSI Model MSX10) is a photovoltaic power source to be used with rechargeable lead-acid batteries. The voltage output from the panel is unregulated and is intended to be used as an input to a battery float charger circuit. Performance characteristics are:

Nominal Voltage	16 volts DC
Peak Power	10 Watts

These are typical panel characteristics at 1 Kilowatt per square meter illumination and 25 degrees C. Individual panels may vary up to 10 percent. The panel voltage output increases slightly as the panel temperature decreases.

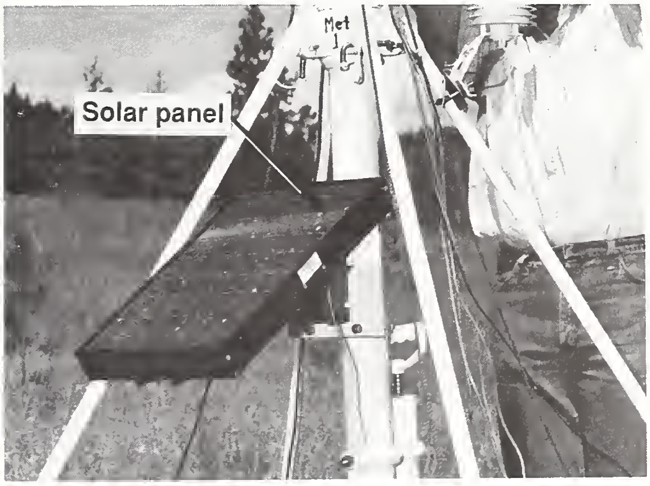

Figure 18.–Solar panel.

Windspeed(7) (Figure 19).—The windspeed sensor (Met One 01A, CSI) uses a durable 3-cup anemometer assembly and simple magnet-read switch assembly to produce a series of contact closures whose frequency is proportional to windspeed. The performance characterisitcs are:

Maximum Operating Range	0 to 60 meters/sec (0-125 mph)
Starting Speed	0.5 meters/sec (1 mph)
Calibrated Range	0 to 50 meters/sec (0-100 mph)
Accuracy	± 1.5% or 0.25 mph
Temperature Range	-50 deg C to +85 deg C

Figure 19.–Windspeed sensor.

Wind Direction(8) (Figure 20).—The wind direction sensor (Met One 024A, CSI) uses a lightweight airfoil vane and a potentiometer to produce an output that varies proportional to wind direction. The performance characteristics are:

Azimuth	Electrical 0 to 356 degrees
	Mechanical 0 to 360 degrees
Threshold	1.0 mph
Accuracy	± 5%
Temperature Range	-50 deg C to +70 deg C

Figure 20.–Wind direction sensor.

W-Component(9) (Figure 21).—The vertical direction wind sensor (Gill Propeller Anemometer, supplied by the Young Corporation) uses an analog voltage output that corresponds linearly to vertical windspeed. The performance characteristics are:

Threshold	0.2 meters/sec (0.4 mph)
Range — Axial Flow	30 meters/sec (70 mph)
— All Angle Flow	22 meters/sec (50mph)
Accuracy	± 0.2% 0.2 to 20 meters/sec
	± 1% above 20 meters/sec

Figure 21.–Vertical direction wind sensor anemometer.

Temperature(10) (Figure 22).—The lower temperature probe (CSI Model 107), for use in air or soil, incorporates the Fenwal Electronics UUT51J1 Thermistor in a water-resistant probe. The probe is inserted into a Gill Radiation Shield to offset the effects of direct sunlight. Accuracy of the probe is ± 0.4 deg C over the range of -33 deg C to +48 deg C.

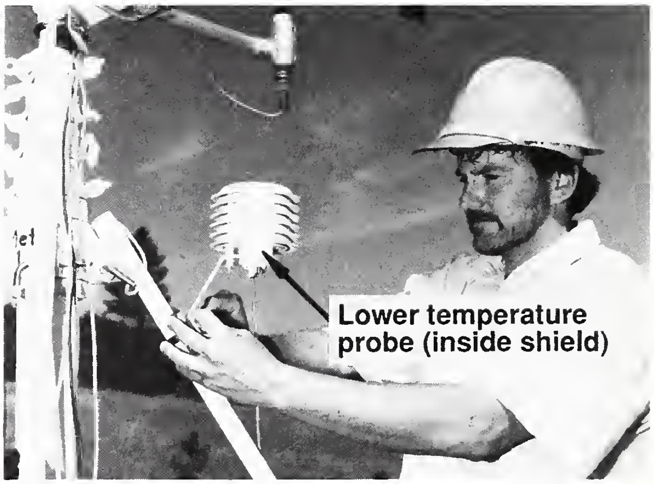

Figure 22.–Lower temperature probe.

Relative Humidity(11) (Figure 23).—The relative humidity sensor (CSI Model 207) consists of a Phys-Chemical Research PCRC-11 sensor inserted into a Gill Radiation Shield. The probe also contains the same temperature sensors used in the Model 107 Temperature Probe. The computer measures the temperature first and then the resistance in the relative humidity sensor to determine the percent relative humidity. Accuracy is typically better than ± 5 percent over the 12 to 100 percent relative humidity range.

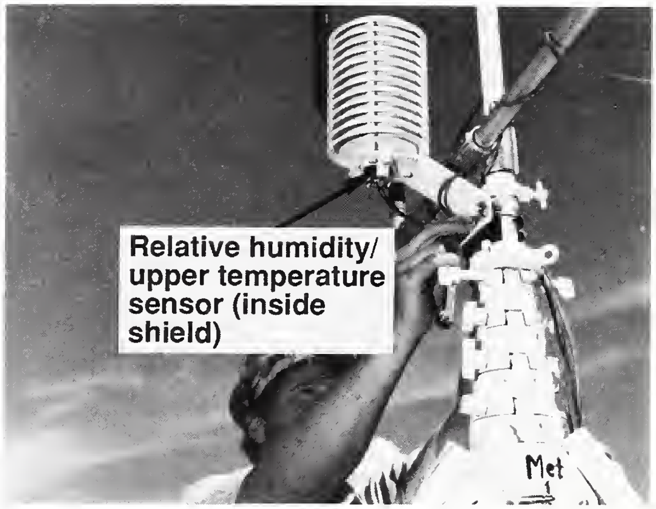

Figure 23.–Relative humidity sensor.

EMCOT Station Deployment

Before Station deployment, check with local frequency managers to get clearance to use the frequencies in the EMCOT Station. If frequency is restricted, reprogramming of the Station will be necessary. The first step in deploying the EMCOT Station is site selection. The site slope angle cannot exceed 20 degrees. It is wise to place the mast support legs so that the solar panel mounting bracket is facing due south. (Tip: Use compass to determine south). Extend mast support legs and position mast vertically. (Tip: Use bubble level to aid in positioning, Figure 24). Pace off 12 feet from base of mast and drive guy stake (four places).

Figure 24.–Bubble level aids positioning.

(Tip: Have stakes positioned from center of mast axis on same radii as support legs). Drive mounting rod and attach RF Substation. (Tip: Position RF Substation mounting rod close to mast to insure sensor wire length is sufficient after full extension of mast. Attach solar panel to mast and adjust to optimize solar radiation collection (about 45 degrees from the horizontal). Attach W-Component mounting rod to the horizontal bar. Attach W-Component sensor to W-Component mounting rod (Figure 25). Attach this horizontal bar assembly to the top of the mast. Check that horizontal bar and sensor mounts are level using the bubble level (Figure 26 a&b). Attach 3-cup anemometer and directional wind vane to horizontal bar . (Tip: Position horizontal bar aligned north and south.) Have wind vane positioned on the north end of the horizontal bar to allow easier access to sensor during final positioning of wind vane. (Tip: All sensor wires should be wrapped around structure, Figure 27, to insure wire is not jerked from sensor during mast extension.)

Figure 25.–W-component mounting rod.

Figure 26a.–Use bubble to insure that the horizontal bar is level.

Figure 26b.–Use bubble to insure that the sensor mounts are level.

Figure 27.–Sensor wires should be wrapped around structure.

Attach temperature probe containing relative humidity sensor just below horizontal bar. Attach lower temperature probe to support leg of mast. Attach guy rope to mast and guy stakes or equivalent. (Tip: Let out slack in guy rope tensioning device to avoid delays in mast extension.) Position all wires so they will not tangle upon ascent of mast. Insert sensing wires into CR10WP Wire Block located in RF Substation. (Tip: It is wise to take some time to look at the data being displayed on the datalogger keyboard to see if it looks reasonable as a check on correct wire installation).

Orientation of the wind vane is next. Use output from the computer program 'LATLONG.EXE' to determine azimuth of sun for the given latitude, longitude, and time of day at the test site. With the tip of the wind vane pointed directly at the sun, rotate the base of the vane with respect to the horizontal bar and read off the sun direction from the LED keyboard in the RF Substation (Figure 28a). When the reading matches the computer output, tighten the wind vane shaft. (Tip: A piece of paper or hand positioned behind fins of wind vane can be used to determine when tip of vane is pointed directly at the sun (Figure 28b). The least amount of shadowing will be present from the fins when vane is pointed directly at sun.).

It should be noted that on the Heather Spray Project the experimenters were concerned about pesticide contamination of their equipment. To minimize clean-up and possible corrosive effects on equipment, all exposed areas (except sensors) were enclosed in either paper towels or plastic garbage bags. Clear plastic was placed over the solar panel to allow continued solar radiation collection during and after spray application. Protective wrapping of cylinder sections took place as the mast was extended. To extend the mast, close air valves to air pump and base section of mast. Loosen wing nuts that hold top cylinder section in place. Pump up the top section until it is fully extended and tighten wind nuts. Loosen the next lower section wing nuts and continue pumping up cylinder sections in this fashion until the mast is fully extended. The telescoping cylinders have a slot in them that insures the

Figure 28a.–Tip of wind vane pointed directly into sun.

Figure 28b.–Paper can help determine when tip of vane is directly in the sun.

horizontal bar does not rotate around the vertical axis of the mast during extension. To ensure that the mast remains in as vertical a position as possible, after the mast is extended, the guy ropes are adjusted and tightened using a plumb-bob as a sighting instrument (Figure 29). Slight tension is first put on the guy ropes. The air is then bled out of the mast. The technician stands away with the plumb-bob and determines which guy ropes need to be adjusted to insure a straight vertical mast (Tip: this procedure goes fast with two people. The technician operating the plumb-bob stands directly out from the support legs. Two measurements taken 90 degrees from each other are adequate.) Retraction is basically the reverse of extension. The mast must be repressurized and slowly bled off as each section is lowered. When finally down, the air valves are to be left open for storage and all section wing nuts tightened for transport. As far as the hardware deployment of the EMCOT Station is concerned, a single technician can do it. Once two technicians become familiar with the deployment procedure, they can set up the system in about an hour and take it down even more quickly.

Figure 29.–Plumb-bob used as sighting instrument.

The MET Tower And The PC

The portable computer administers an important role in the acquisition and manipulation of the data obtained by the MET tower. Via the software, PC 208 datalogger support software, supplied by Campbell Scientific, operation of the datalogger can be performed remotely. This software supplies a powerful program editor, EDLOG, fashioned exclusively for the datalogger's programming needs. PC 208 also accommodates two programs designed for the remote retrieval of data: TELCOM and TERM. Further features include a data formatting program, SPLIT. SPLIT produces a file with data in a report format, ready for importing to LOTUS 123 or other popular graphing programs. All of the combined features of the PC 208 software grant the user the ability to produce fast and accurate reports of immediate data.

Data Acquisition

The fully programmable CR10 datalogger possesses a variety of capabilities. It is backed by a large array of mathematical functions, making it a multifaceted computer. The expandable memory of the CR10 allows it to store large quantities of data.

To gather data, the datalogger must first be programmed to interpret the signals it receives. The CR10 datalogger comes equipped with a CR10K keyboard which gives the user of the datalogger complete control. Programming from the CR10K keyboard, however, is at best tedious. At the keyboard programming is performed entirely in numbered codes. EDLOG provides a much more viable solution.

EDLOG makes the task easy by employing a programming environment exclusively dedicated to a CSI datalogger. On-line help provided by the software, allows the user to choose the measuring device to be implemented from a menu. On-line help also provides the user with a list of instructions for storing the data it receives.

The CR10 datalogger provides the user with a variety of data storage techniques. Data can be stored as averages, standard deviations, maximums or minimus, totals, and histograms. The datalogger also has in it's arsenal a powerful math library. This library includes trigonometric and exponential functions, as well as common arithmetic .

A unique feature of the MET tower is its ability to run the datalogger on the solar panel supplied by the MET tower. The solar panel supplies the datalogger with power during the day, and also charges the backup battery to be used during the night. When implemented, the solar panel allows continuous datalogger use.

With an unlimited power supply the only limitation on the quantity of information the data logger can retrieve is the amount of available memory. The CR10 can have either 16K or 64K of memory. With the latter option, 14.952 high resolution[1] data points are dedicated to final storage by default. Final storage is the body of memory set aside for storing processed data. After the total number of data points exceeds available memory, the datalogger begins to write over the oldest data. The program placed inside the datalogger determines how long (days, hours, minutes) the computer will write data to final storage before it will begin overwriting old data.

Data are gathered by the datalogger on what is referred to as a data interval. The data interval is assigned at the beginning of the program level and determines how often (in seconds) the datalogger will retrieve data. The data interval can be as small as 1/64 of a second or as long as 8191 seconds (136.5 minutes). Most operations made by the datalogger are performed in tenths of a micro second (1/10000), thus a dozen operations can easily be performed in the smallest interval.

The CR10 datalogger maintains two independent program levels. The execution of the first level takes precedence over the second. Where time is a critical factor for data, operations can be placed in the priority program level to ensure accurate measurement. Operations on data that are less time dependent can be performed from level two.

Once data is gathered by the datalogger, it is placed in input storage. Input storage contains the data most recently obtained. Data are stored in input storage only until the program interval has elapsed, at which time input storage willl again be updated with the most current readings. This cycle will continue for as long as the data logger is running.

[1] A high resolution data point occupies four bytes of memory. Alternately a low resolution data point occupies only two bytes, and therefore twice as many can be stored. Accuracy is five places for high resolution and four for low. The number 14,952 can be slightly modified depending on the characteristics of the currently running program.

Data readings in input storage are not necessarily placed in final storage after every run of the program level. Specific instructions must be placed in the program to instruct the datalogger to store data in final storage. These output instructions are usually a time dependent condition, i.e., every (x) minutes.[2]

Data Retrieval

There are several options available for retrieving data from the CR10 datalogger. Data can be viewed at the datalogger itself, or it can be retrieved remotely by portable computer and the PC208 software.

The CR10K keyboard is particularly effective for monitoring current input values. With only two keystrokes, the CR10K can be displaying the current data as it is recorded in input storage. Due to the large quantity of data, the keyboard is not a good means to examine final storage. This task is best left to the PC.

The retrieval of data stored in final storage can be performed by the PC and the PC208 Software. When using this software, data can be retrieved remotely by a Radio Frequency Modem. An RF Modem receives and transmits information to and from the datalogger and the PC. TELCOM and TERM are two programs designed to use the RF Modem to communicate with the data logger.

Data is retrieved from the datalogger using TELCOM. This program collects data from the datalogger, and stores it in a DOS text file. The first time TELCOM is initiated, all data that reside in final storage of the datalogger are transferred to a file. Each successive call will: (A) Gather only that data which are new, and (B) append it to the end of the current data file.

TERM complements the PC208 Software with a variety of useful features. The TERM software can save and file an exact copy of the currently running program or it can load a program created by EDLOG into the dataloggers' program memory. From the remote PC outpost using TERM, the computer can function as the CR10K keyboard. TERM also possesses the ability to monitor current input reading as they are recorded by the datalogger.

Data Manipulation

After data have been gathered in a file with a PC and the TELCOM software, the data are still in a "raw" form represented by countless lines of numbers. A line of

[2] The CR10 data logger is equipped with a real time clock including the current Julian day.

numbers in the file represents one execution of the program interval. Numbers on a line are separated by a comma. Each number represents one output. On each line, there will be a number for every output made during the execution of the program interval.

The interpretation of these numbers is left up to the individual who programmed the datalogger. Only this individual will know the order in which the outputs were made during a program interval; i.e., time, temperature (lower), temperature (upper), delta temperature, etc.

A down-loaded data file can grow rapidly in size. These large data files make data manipulation cumbersome. To alleviate this problem PC208 software employs the program SPLIT. SPLIT allows the user to extract only that data of interest. SPLIT performs this task through a nest of user-defined comparisons; i.e., after this time, but before that time, get data from field #5, 7, 11 (the 5th, 7th, and 11th number in the line) if the number in field #8 is less than X or greater than Y. This program commonly will be used to extract two or three fields of data occurring between a certain time. Most often the extracted data will include a time field for graphing.

The newly extracted data is placed in a file also composed entirely of numbers. This file is now ready to be imported by a user-preferred graphing program, i.e., LOTUS 123. From there a graph can be constructed and labels can be affixed to the axis, bars, etc., to make a highly readable and professional looking report of the day's data.

The Campbell Scientific, Inc. CR10 datalogger is a remarkable scientific instrument. Working with a personal computer, equipped with a Radio Frequency Modem, and the PC 208 software, the datalogger performs exeptionally in gathering data measured from the MET tower. The datalogger is versatile in that it can be programmed to operate under an extensive range of conditions. The EDLOG software supplied by CSI makes programming the datalogger a manageable task. When the datalogger implements expanded memory, large data capacities exist. After data have been collected, retrieval from the datalogger can be performed by the PC using the TelCom software. Data of interest are then separated using SPLIT, and a report is formed using a PC-compatible graphing program. All of this technology combines to make the CR10 datalogger a productive and dependable instrument, complementing the MET tower.

Results

The EMCOT Station was used on the Heather Spray Project on two occasions. The dates of the spray applications were June 6 and July 6, 1989.

On the first occasion, the equipment was delivered on-site by Randy Johnson, Ian electrical engineer from NOAA (National Oceanic and Atmospheric Administration), who came to instruct the Forest Service personnel on how to use the system. The equipment was deployed two days before the spray application and was used as a training aid. The spray application day started at about 0500 hours for the EMCOT Station operators. Because frost or low visibility would shut down the spray application, monitoring was needed. Telecommunications were established at a remote site prior to the spray application. The RF base station personnel observed the spraying from a clear-cut about 1/2 mile from the spray zone. Throughout the application real-time weather conditions were monitored. The first aerial application took place before the relative humidity sensor had arrived. Consequently, the percent relative humidity was manually monitored every 5 minutes with a sling psychrometer. The monitoring took place outside the application area due to toxicity of the material. After the application was over, the observers collected data from the datalogger remotely and plotted several charts on the computer monitor. A minimum of 12 hours passed, as recommended by the chemical manufacturers, and then the EMCOT Station was taken down. Except for removing the paper towels, the Station came down easily.

On the second occasion, the EMCOT Station was deployed and run strictly by Forest Service personnel. The Station was erected the day before the spray application with no difficulties. The spray application was conducted almost identically to that done on the first occasion. Shortly after the spray application, data from the datalogger were retrieved and used to make permanent paper charts of time-related meteorological events. The following day the equipment was dismantled and taken home. It should be noted that the computer printer as well as the relative humidity sensor were added to the EMCOT station after the June 6 spray application.

The system performed efficiently on both trials. The good points of the system include:

1. Portability — The system may be easily transported in the back of a vehicle. It may also be shuttled across open land areas due to packaging of the components (Figure 30).

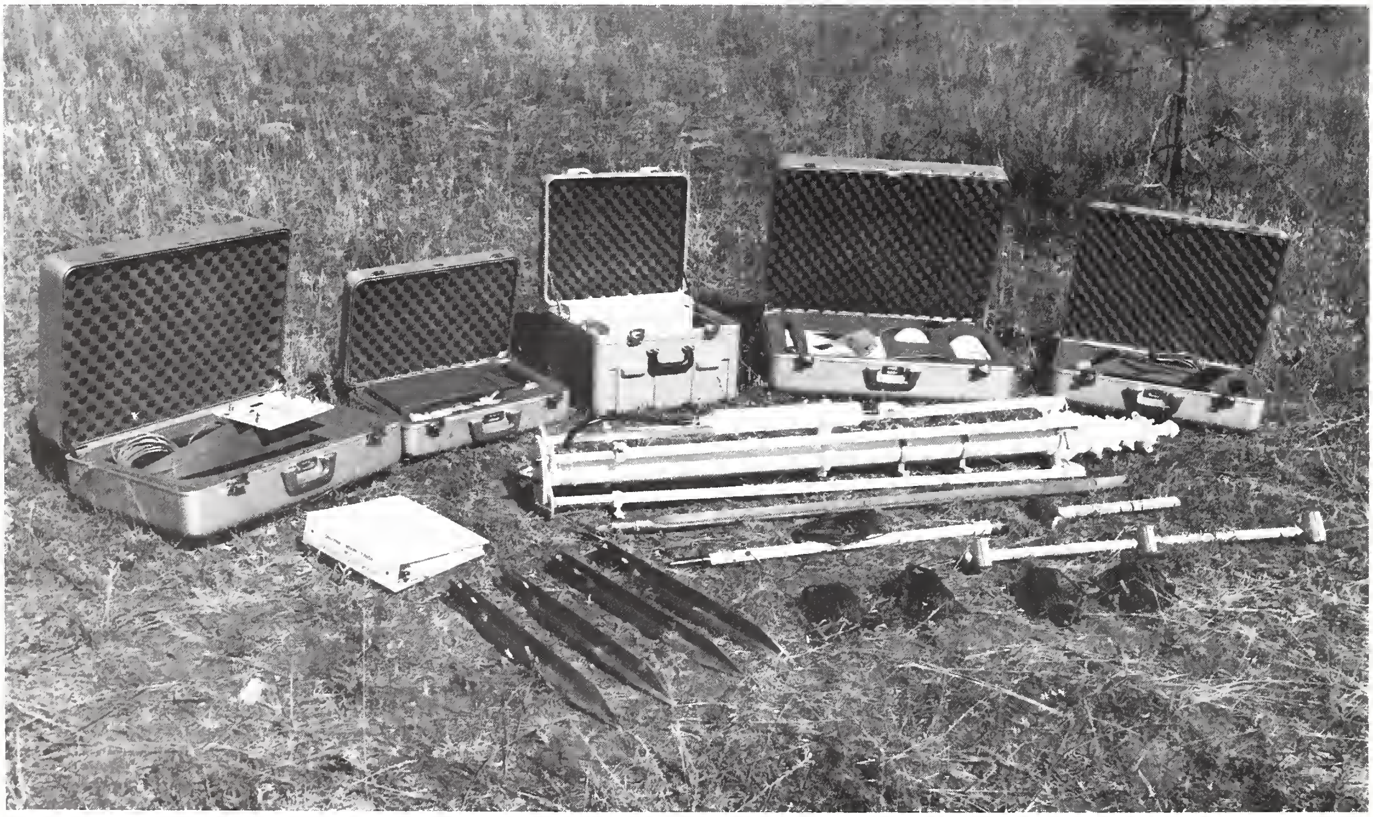

Figure 30.–EMCOT Weather Station components.

2. Rapid Deployment Time — The system may be deployed in about 1 hour by experienced personnel. Take-down requires even less time.

3. Minimal Personnel Required — The system can be deployed by a single technician.

4. Easily Expanded to Add New Sensors — Any electrical device which emits an analog or pulse signal can be adapted to the system.

5. Easily Modified Software — The system can be easily reprogrammed to accept new sensors or perform numerous mathematical manipulations of collected data.

6. High Frequency of Data Collection — The throughput rate is the rate at which a measurement can be made and the resulting value stored in Final Storage. The maximum throughput rate for fast single-ended measurements with standard software is 192 measurements per second (12 measurements repeated 16 times per second).

7. Large Data Storage Capacity — The default size of final storage in the CR10 is 29908 two byte locations in the 64k version (i.e., if 2-minute averages are stored for 21 data points, the datalogger can store approximately 47 hours of data.)

8. Real-time Monitoring of Data — Meteorological events can be monitored as they occur at the test site through the remote RF base station. Up to 255 stations can be monitored, although not simultaneously.

9. Near Real-time Graphic Display of Averaged Data (over operator-selected time interval) — Stored data files can be processed in the field to graphically display meteorological activity at test site over selected time interval on the computer monitor. As soon as a 120-volt AC power supply is available, hard copies of the graphs can be made with the printer.

For more information, contact Robert Ekblad, Project Leader, USDA Forest Service, Missoula Technology & Development Center, Bldg. 1 Fort Missoula, Missoula, Montana 59801.

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